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Bescheinigung | Certificate | Attestation

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The attached documents are exact copies of the European patent application described on the following page, as originally filed.

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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

99202673.2

PRIORITY DOCUMENT
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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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Page 2 de l'attestation

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Applicant(s):
Demandeur(s):
N.V. BEKAERT S.A.
8550 Zwevegem
BELGIUM

Bezeichnung der Erfindung:
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Titre de l'invention:
Diesel exhaust particulate filter system

In Anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

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Field of the invention.

The present invention relates to a method of regenerating the filter or the filters of a diesel exhaust particulate filter system.

Background of the invention.

As legislation with respect to environmental issues is becoming more and more severe, diesel exhaust particulate filter systems are more and more applied in the exhaust pipes of diesel engines to trap the particulates present in the diesel exhaust gases. As particulate matter is building up on the filter membrane, pressure drop increases until a threshold is reached. The determining factor to set the threshold is to safeguard the normal functioning of the diesel engine.

Some existing filter systems allow regeneration so that they can be used again during a subsequent period. The regeneration mainly constitutes in burning the trapped particulate matter present in the filters. This regeneration can be basically done in two ways.

One way is an electrical regeneration where the filter material is heated in an electrical way until above the ignition temperature of the particulate matter. Another way is the installation of a burner which generates a flame which reaches until the filter material to burn all present particulat matter.

Both ways, however, have their respective disadvantages.

Apart from disadvantage caused by the unavoidable presence of electrical contacts and necessary electrical insulation means, the main disadvantage of the electrical regeneration system is that it involves a high degree of electrical power, which may cause substantial charge losses to the vehicle battery and which increases the consumption of fuel.

A disadvantage of the burner regeneration is that flames are generated in the exhaust pipes, which causes mechanical stresses and corrosion. Other disadvantages are that such burner regeneration systems require complex, large size and expensive combustion chambers with a high energy consumption and a high maintenance cost.

Summary of the invention.

It is an object of the present invention to avoid the disadvantages of the prior art.

It is another object of the present invention to provide an efficient, compact and inexpensive regeneration system for diesel exhaust filters.

It is also an object of the present invention to provide a regeneration system for diesel exhaust filters which consumes only a low amount of energy.

According to a first aspect of the invention, there is provided a method of regenerating a filter of a diesel exhaust particulate filter system. The method comprises as steps :

a) providing a poruous membrane ;
b) using the membrane as filter during a filtration period ;
c) using the membrane as a surface combustion burner membrane during a regeneration period which follows the filtration period.

The use of a porous membrane both as filter membrane and as surface combustion membrane makes the system very efficient, compact and inexpensive.

According to a second and preferable aspect of the present invention, there is provided a method of regenerating a diesel exhaust particulate filter system, wherein following steps are occurring :

a) providing at least two porous membranes ;
b) using at least one of said membranes as filter during a filtration period ;
c) using at least one of the remaining membranes as a surface combustion burner membrane during a regeneration period which overlaps with said filtration period.

In comparison with the embodiment of the first aspect where the regeneration period follows the filtration period, this embodiment allows regeneration to be done during the operation of filter system.

The porous membrane can be made out of a suitable heat and corrosion resistant material such as a ceramic material or a stainless steel. Preferably the membrane is made of a stainless steel fiber web which is sintered.

Suitable stainless steel alloys are Fe-Cr-Al alloys.

A first group of Fe-Cr-Al based alloys comprises 15 to 25 % Cr and 4 to 6 % Al. Preferably the Al content is between 4.8 and 5.7 %.

A preferred alloy composition is an Fe-Cr-Al based alloy further comprising Y. This alloy is known as Fecralloy®.

The Y content ranges from 0.03 to 0.5 % and is preferably between 0.08 and 0.35 %. Most preferably the Y content is between 0.25 and 0.35 %.

Another possible alloy composition is an Fe-Cr-Al based alloy which further comprises at least one additional element selected from the group consisting of Sc, Y, Ti, Zr, Hf, V, Nb, Ta and the lanthanides, for example La or Ce. The content of the additional element or the sum of the additional elements is between 0.01 and 1%.

A second group of Fe-Cr-Al based alloys comprises up to 15 % Cr and 20 to 60 % Al. These alloys further comprise at least one additional element selected from the group consisting of Sc, Y, Ti, Zr, Hf, V, Nb, Ta and the lanthanides.

Fiber diameter, amount of fiber in weight per square meter and porosity are determined in function of :

1) the filter rating so that very fine particulate matter can be captured ;
2) the dirt holding capacity so that the frequency of regeneration can be kept to a minimum.

A typical example of a suitable fiber medium is a fiber diameter of 22 µm and a weight of 1050 g/m².

During the regeneration period or cycle the stainless steel fiber web responds very quickly due to its small thermal mass and keeps the regeneration period to a strict minimum. As a consequence, the energy consumption during the regeneration cycle is also kept as small as possible.

During the regeneration period fuel is provided to the stainless steel fiber web. This fuel is preferably diesel as this is readily available. The diesel is preheated by the heat of the warm air coming from the engine and used as combustion air. By preheating the diesel is vaporized and after ignition beyond the membrane, combustion occurs in radiant mode. So, apart from the soot particulate matter, the only mass which needs heating up is the stainless steel fiber web, which is known to have a low thermal mass. This explains the short regeneration cyles or periods and the low energy consumption.
Combustion occurs then in radiant mode at the surface of the stainless steel fiber web. So no separate burner to heat up the stainless steel fiber web is required.
Another phenomenon which helps to reduce the energy consumption is as follows. The combustion of the particulate matter present in the stainless steel fiber web is an exothermic reaction, which, once initiated, keeps burning even after gradually reducing the diesel input.

According to an advantageous embodiment of the present invention, the method comprises the step of monitoring the pressure drop across the porous membrane during the filtration period. As particulate matter is building up at the surface of said membrane and in the membrane, this pressure drop increases during filtration. Once the pressure drop across the membrane reaches the threshold, which is checked automatically using a pressure gauge, the filtration period or cycle stops and the regeneration period or cycle starts.

Brief description of the drawings.

The invention will now be described into more detail with reference to the accompanying drawings wherein

- FIGURE 1 schematically shows the functioning of a diesel exhaust particulate filter system according to the second aspect of the invention.

Description of the preferred embodiments of the invention.

FIGURE 1 schematically shows the functioning of a diesel exhaust particulate filter system 10 according to the second aspect of the invention, where filtration and regeneration may occur in parallel. The diesel exhaust particulate filter system comprises at least two modules 12, 14 which are placed in parallel. Each module 12, 14 comprises a stainless steel fiber web 16, 18. This stainless steel fiber web is present in the form of a cylinder. Other forms, such as planar strips, are also possible. The diesel exhaust gases are guided via pipe 20 which at its end splits up into two separate inlet pipes 22, 24 leading resp. to module 12 and module 14. Valve 26 in inlet pipe 22 and valve 28 in inlet pipe 24 control the flow of the exhaust gases. The diesel fuel can be injected via inlet pipe 30 to module 12 and via inlet pipe 32 to module 14. Valve 34 in inlet pipe 30 and valve 36 in inlet pipe 32 control the flow of the diesel fuel. Exit pipes 38 and 40, resp. for modules 12 and 14, guide the filtered exhaust gases away from the diesel engine. Exit pipes 42 and 44, resp. for modules 12 and 14, guide the burner gases away from the diesel engine. Valves 46, 47, 48 and 49 control the flow.

In the situation as shown in FIGURE 1, module 12 functions as filter whereas module 14 is being regenerated. Valv 28 is in a closed position and thus prevents the exhaust gases 50 from flowing to module

14. Valve 26 is in open position and allows the exhaust gases 50 to module 12. Valve 34 is in closed position, so no diesel is injected into module 12. The flow of exhaust gases 50 is radially inwards in the stainless steel fiber web cylinder 16 (as pointed out by the arrows). As particulate matter is building up at the radially outer surface of the steel fiber web cylinder 16, the pressure drop over the steel fiber web increases. This pressure drop is sensored by means of a pressure gauge which is positioned downstream (not shown). Once a predetermined critical level is passed, signals are given to the respective valves to have module 12 operated in regeneration mode and module 14 in filter mode.

The filtered exhaust gases are axially guided away from the diesel engine via exit pipe 38 and valve.

In the meantime, valve 36 is in open position and allows diesel to be injected into module 14. The diesel fuel 52 is heated by the present warm air coming from the engine and is ignited. Any particulate matter present on stainless steel fiber web 18 is burned away and the thus created exhaust gases 54 are led away via valve 47 and exit pipe 44. A flame is only present on the surface of steel fiber web 18. No flames are present in the various pipes.

The diesel exhaust particulate filter system can be mounted on diesel motors for vehicles as well as for diesel motors functioning outside vehicles such as in stand-alone electrical generation systems.

CLAIMS

1) A method of regenerating a filter of a diesel exhaust particulate filter system, said method comprising as steps :
   a) providing a porous membrane ;
   b) using said membrane as filter during a filtration period ;
   c) using said membrane as a surface combustion burner membrane during a regeneration period following said filtration period.

2) A method of regenerating a diesel exhaust particulate filter system
   a) providing at least two porous membranes ;
   b) using at least one of said mebranes as filter during a filtration period ;
   c) using at least one of the remaining membranes as a surface combustion burner membrane during a regeneration period which overlaps with said filtration period.

3) A method according to claim 1 or 2, wherein said membrane is a stainless steel fiber web.

4) A method according to any of the preceding claims, said method comprising the step of providing fuel to said membrane during the regeneration period.

5) A method according to claim 4 wherein said fluid fuel is diesel.

6) A method according to any of the preceding claims, said method further comprising the step of :
   - monitoring the pressure across said membrane during the filtration period.

7. A method according to claim 6, said method further comprising the step of :

- generating a control signal to regenerate said membrane, once the pressure across said membrane exceeds a predetermined level.

ABSTRACT :

A method is provided for regenerating a filter of a diesel exhaust particulate filter system (10). The method comprises as steps :

a) providing at least one porous membrane (16, 18) ;

b) using said membrane (16, 18) as filter during a filtration period ;

c) using said membrane (16, 18) as a surface combustion burner membrane during a regeneration period.

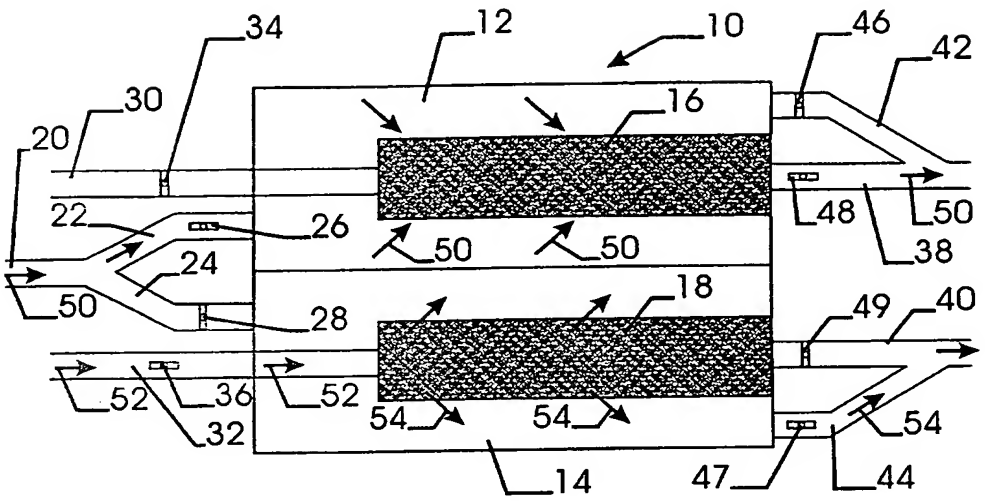
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Fig. 1